# The Upcoming Release of the Improved OMI Nitrogen Dioxide Standard Product


Edward A. **Celarier** [1]
Eric J. **Bucsela** [2]
Nickolay A. **Krotkov** [1]
James F. **Gleason** [3]
Pawan K. **Bhartia** [3]

[1] Goddard Earth Science & Technology Center,
University of Maryland Baltimore County, Baltimore MD
[2] SRI International Corp., Menlo Park CA
[3] Code 613.3, NASA Goddard Space Flight Center, Greenbelt MD



**ABSTRACT**

- A new release of the OMI Nitrogen Dioxide ($NO_2$) Standard Product is planned for January 2011.
- The new release will correct, improve, and augment the current version.
- The data product will be made available on the Goddard Earth Sciences Data & Information Services Center (GES-DISC) [1].
- Derivative data products, including station overpass and Level-3 products, will be available on the Aura Validation Data Center (AVDC) web site [2].
- Data are also available via the GIOVANNI web-based application [3].
- Many of the changes have been made to respond to suggestions by the user community, and will enhance ease of use and interpretation.

Specific improvements include:
(1) Replacement of annual a priori profile climatologies with monthly climatologies;
(2) The expansion of the lookup tables used in the $NO_2$ retrievals;
(3) Improved table interpolation to reduce errors;
(4) Improved handling of the cross-track bias and row anomaly;
(5) Inclusion of averaging kernels; and
(6) Expanded metadata.

Further changes are anticipated, including better stratosphere and troposphere separation and improved treatment of the effects of clouds and aerosols, over the course of 2011, with another reprocessing planned in 2012. (See poster by N.A. Krotkov et al.)

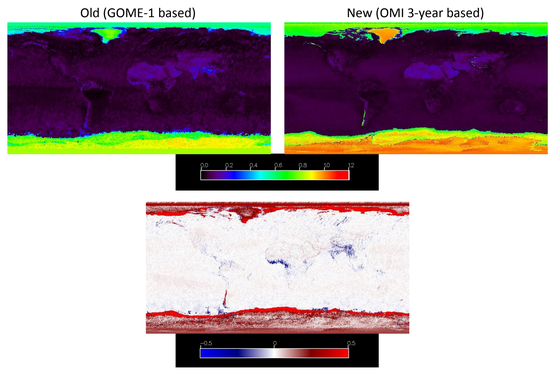

[1] http://disc.sci.gsfc.nasa.gov/Aura/data-holdings/OMI
[2] http://avdc.gsfc.nasa.gov
[3] http://giovanni.gsfc.nasa.gov

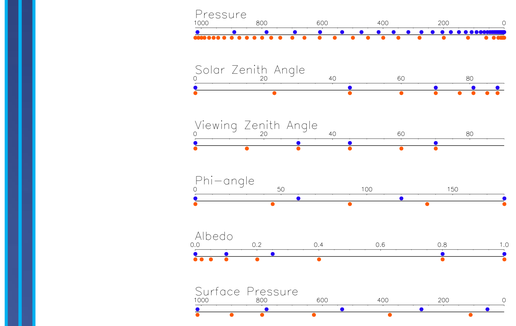
| Application | Other required input products |
|---|---|
| OMNO2A | OMCLDO2 (cloud fraction, cloud height)<br>Surface reflectivity climatology<br>NISE (snow & ice coverage)<br>Molecular absorption cross sections ($NO_2$, $O_3$, $O_2$-$O_2$, $H_2O$)<br>Reference solar spectrum<br>Cloud radiance fraction table (radiative transfer calculation results) |
| OMNO2B | Differential air mass factor table (radiative transfer calculation results)<br>Unpolluted profile shape<br>Polluted profile shape climatology (GEOS-Chem results)<br>Temperature profile climatology |
| OMNO2 | Pollution source mask |

## Surface reflectivity climatology

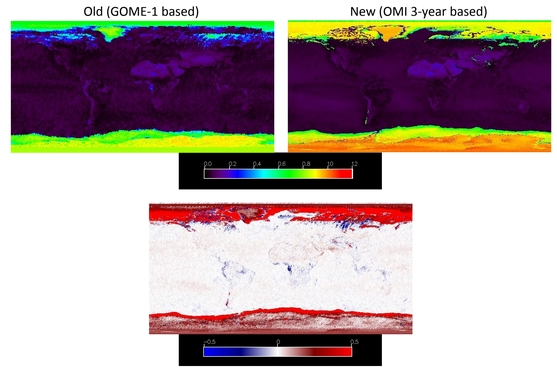
- Original product used GOME-derived monthly climatology
- After Feburary 2009, product used OMI (3-year)-derived monthly climatology
  - No reprocessing
- By January 2011, product will use OMI (5-year)-derived monthly climatology
  - To be in forward processing around November 2010
  - Full reprocessing in January 2011
- OMI (3-year) reflectivities are generally greater than the GOME-derived reflectivities, especially over ice.

## Surface Reflectivity climatology: July

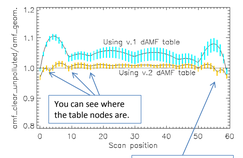



## Surface Reflectivity climatology: October




## New dAMF table, versus Old.



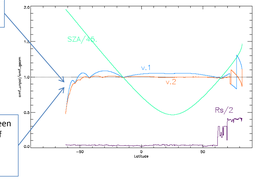

Unpolluted AMF over relatively unpolluted region (in this case equatorial West Pacific) should approximately equal the geometric AMF, i.e. (sec $\vartheta_o$ + sec $\vartheta$).

Scan position dependence reflects $D(\vartheta)$.

Latitude dependence reflects $D(\vartheta_o)$.

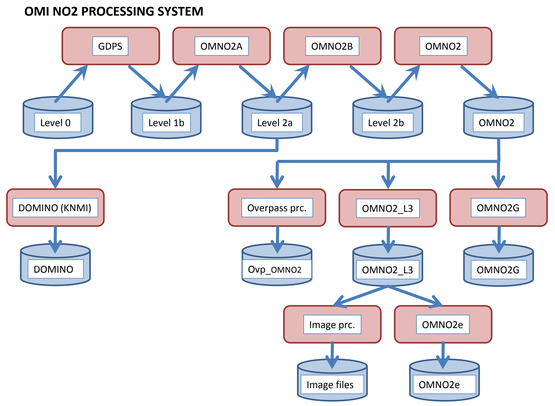
Deviation from unity for large angles is real.

The new algorithm will use an optimized polynomial interpolation, which will significantly reduce the lumps.

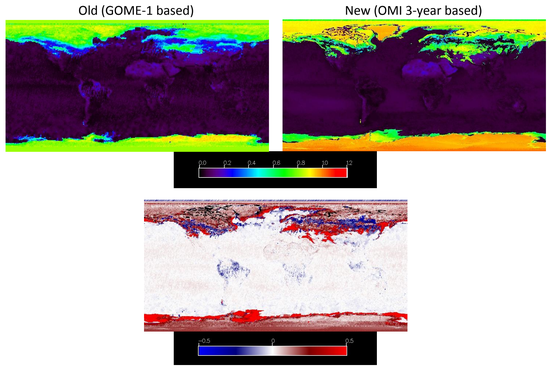



Curvature (lumps) between the nodes is the result of using multilinear interpolation when the true function is curved

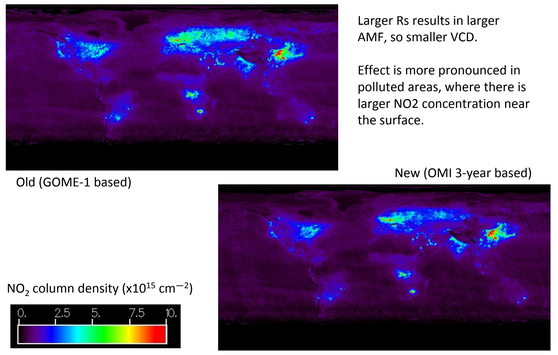
## OMI NO2 PROCESSING SYSTEM




## Surface Reflectivity climatology: January




## Effect of change in surface reflectivity on tropospheric $NO_2$ – June 2009




Larger Rs results in larger AMF, so smaller VCD.

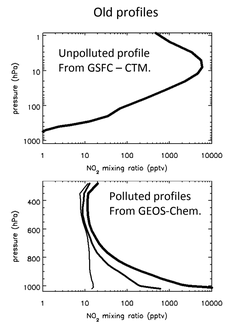
Effect is more pronounced in polluted areas, where there is larger NO2 concentration near the surface.

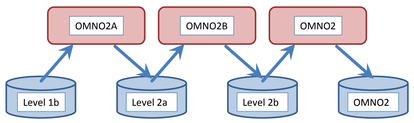
## A priori profiles

The AMFs must be calculated using assumed profile *shapes*. You don't need the absolute profile.
We don't have a database of *in situ* profile measurements, so we turn instead to chemistry and transport model-derived profiles.

Old version used a single stratospheric (unpolluted) profile shape everywhere, and for all times of the year, appended to a geographical grid (at 2°x2°) of tropospheric profiles (see figures on the right).

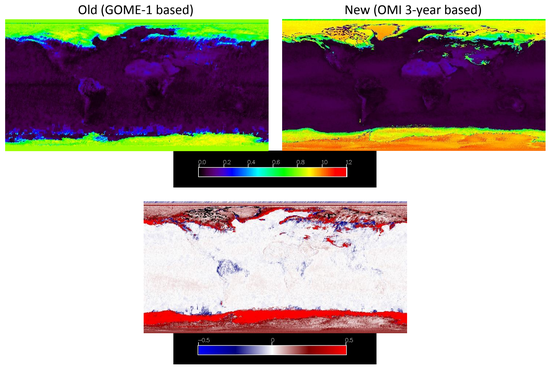
None of the profiles were time-dependent. This resulted in pronounced annual cycles in ratios or differences between OMNO2 and other results (observational, model, or other OMI retrievals).




| Application | Purpose |
|---|---|
| OMNO2A | Fit observed I/Fo to reference molecular spectra to get SCDs |
| OMNO2B | Calculate partial AMFs<br>(clear/cloudy; polluted/unpolluted) |
| OMNO2 | Separate stratospheric and tropospheric components<br>Calculate final AMFs and VCDs. |

## Surface Reflectivity climatology: April




## Differential Air Mass Factors

Definition of Air Mass Factor:
AMF = SCD/VCD

For an optically thin absorbing gas,

$$AMF = \int dp\, X_{a\text{-}p}(p)\, D(p; \Theta, p_s, R_s) \,/\, \int dp\, X_{a\text{-}p}(p)$$

where

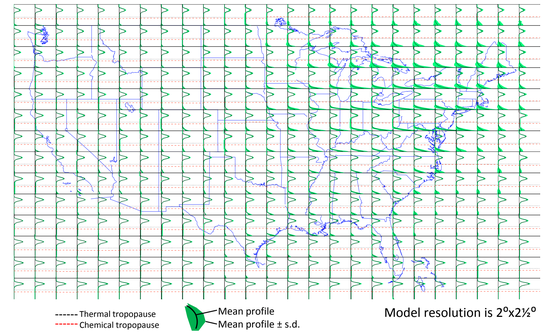
$X_{a\text{-}p}(p)$ = A-priori $NO_2$ vmr profile
D = "Differential AMF"
$\Theta$ = Optical angles (solar & view zenith; relative azimuth)
$p_s$ = Surface pressure
$R_s$ = Surface reflectivity

*D* is got from radiative transfer calculations, and tabulated for a selected set of parameter values.

The Averaging Kernel (AK) is just *D*/AMF

We have changed the tabulated parameter values and the interpolation scheme.

New A priori $NO_2$ profile climatology from GSFC's GMI (GEOS-5) chemical transport model.
Mean of all-June daily profiles over 4 years.




Model resolution is 2°x2½°